INORGANIC NOMENCLATURE

Chemistry is a lot like living in a foreign country. If you speak the language, life is more fun! Learning inorganic nomenclature is the first step toward learning the language of chemistry. Learning the relationship between chemical formulas and chemical names is essential for understanding chemical problems. Inorganic nomenclature is a systematic way of naming the thousands of inorganic compounds we encounter.

Your textbook discusses nomenclature of inorganic compounds. This handout is intended to supplement and complement your book Chapter 7.

There are certain elements, cations, and anions that you **MUST** know before you get started. Position in the periodic table can help you remember many, but not all. For any name you should be able to write the formula and for any formula you should be able to write the name including spelling.

1. You should know the first 38 elements and Au, U, Ag, Sn, Hg, Cd, Sb, I, Xe, Cs, Ba, Rn, Ra, and Pb

2. Compounds with common names:
   H_2O - water
   H_2O_2 - hydrogen peroxide
   NH_3 - ammonia

3. Cations

Names	Symbols
Lithium ion, sodium ion, etc.	Li^+, Na^+, K^+, Rb^+, Cs^+
Beryllium ion, magnesium ion, etc.	Be^{2+}, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}
Hydronium ion	H^+
Aluminum ion	Al^{3+}
Iron(II), Iron(III)	Fe^{2+}, Fe^{3+}
Copper(I), Copper(II)	Cu^+, Cu^{2+}
Silver ion	Ag^+
Mercury(I), Mercury(II)	Hg_2^{2+}, Hg^{2+}
Lead(II), Lead(IV)	Pb^{2+}, Pb^{4+}
Ammonium ion	NH_4^+
Cadmium ion	Cd^{2+}
Zinc ion	Zn^{2+}
Nickel(II), Nickel(IV)	Ni^{2+}, Ni^{4+}
Gold(I), Gold(IV)	Au^+, Au^{4+}
Cobalt(II), Cobalt(III)	Co^{2+}, Co^{3+}
Tin(II), Tin(IV)	Sn^{2+}, Sn^{4+}
Chromium(II), Chromium(III)	Cr^{2+}, Cr^{3+}

4. Common Monatomic Anions

Name	Symbol	Name	Symbol	Name	Symbol
Hydride	H^-	Iodide	I^-	Telluride	Te^{2-}
Fluoride	F^-	Oxide	O^{2-}	Nitride	N^{3-}
Chloride	Cl^-	Sulfide	S^{2-}	Phosphide	P^{3-}
Bromide	Br^-	Selinide	Se^{2-}	Arsenide	As^{3-}

5. Common Polyatomic Anions (two or more atoms)

Name	Formula	Name	Formula	Name	Formula
Nitrate	NO_3^-	Sulfate	SO_4^{2-}	Nitrite	NO_2^-
Permanganate	MnO_4^-	Carbonate	CO_3^{2-}	Dichromate	$Cr_2O_7^{2-}$
Hydroxide	OH^-	Chromate	CrO_4^{2-}	Sulfite	SO_3^{2-}
Cyanide	CN^-	Phosphate	PO_4^{3-}	Chlorite	ClO_2^-
Perchlorate	ClO_4^-	Peroxide	O_2^{2-}	Hypochlorite	ClO^-
Thiocyanate	SCN^-	Chlorate	ClO_3^-	Acetate	$C_2H_3O_2^-$
Bicarbonate	HCO_3^-	Bisulfate	HSO_4^-	Arsenate	AsO_4^{3-}
Oxalate	$C_2O_4^{2-}$	Bromate	BrO_3^-		

6. Acids

Sulfuric	H_2SO_4	Perchloric	$HClO_4$	Hydrocyanic	HCN
Phosphoric	H_3PO_4	Chloric	$HClO_3$	Chlorous	$HClO_2$
Nitric	HNO_3	Hydrobromic	HBr	Hypochlorous	$HClO$
Hydrochloric	HCl	Hydroiodic	HI	Nitrous	HNO_2

7. Bases

Lithium hydroxide	$LiOH$	Magnesium hydroxide	$Mg(OH)_2$
Sodium hydroxide	$NaOH$	Calcium hydroxide	$Ca(OH)_2$
Potassium hydroxide	KOH	Strontium hydroxide	$Sr(OH)_2$
Cesium hydroxide	$CsOH$		
Rubidium hydroxide	$RbOH$		

There are four main classes of inorganic compounds we will learn how to name:

1. Compounds made from single valence metals.
2. Compounds made from multivalent metals.
3. Compounds containing only nonmetallic elements.
4. Acids (next semester)

NOMENCLATURE RULES

Nomenclature is a set or system of names. The nomenclature that is used in chemistry is based on the IUPAC (International Union of Pure and Applied Chemists) convention. The basic rule is that the name of a particular compound must be completely unambiguous – that is, one name means one particular compound and no other. The simplified rules that follow can be used to name the majority of inorganic compounds.

RULES FOR NOMENCLATURE OF SIMPLE COMPOUNDS

RULE 1

The names of ionic compounds are derived from the positive ions and the negative ions in the compound. For nonionic binary compounds, consider the compound to be composed of 2 parts, one positive and one negative.

RULE 2

The positive ion or part is always named first and written first in formulas. The basic rule: if an element is to the left of another element in the periodic table or below it, it is always less electronegative and named or written first.

RULE 3

BINARY COMPOUNDS (2 ELEMENTS ONLY)

(a) Positive element with a fixed oxidation state (metal or hydrogen):

Name of positive element + "negative stem" with –ide suffix.
e.g. $CaCl_2$ calcium chloride

(b) Positive element with a variable oxidation state (metal)**: STOCK SYSTEM** where the oxidation number of a metal is specified with a Roman numeral in parenthesis and the negative ion is named as in (a) above.
OLD METHOD stem name of metal (usually Latin) with the –ic indicating higher oxidation number and –ous the lower.
e.g. CuCl copper (I) chloride or cuprous chloride
$CuCl_2$ copper (II) chloride or cupric chloride

(c) TWO NONMETALS: named as illustrated in (a) with prefixes to indicate how many of each element is present. EXCEPTION: if the first element consists of only one atom, the prefix for it is understood.

e.g. CO carbon monoxide
N_2O_3 dinitrogen trioxide

mono-	1 (omitted if no other prefixes are used)
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

(d) In general, the –ide ending means binary compounds.

EXCEPTIONS:

NH_4Cl	ammonium chloride (ammonium salts)
$Mg(OH)_2$	magnesium hydroxide (metal hydroxides)
$CuCN$	copper (I) cyanide (metal cyanides)

(e) Binary Acids: i.e. hydrogen plus a nonmetal

In gas phase, named as in (a):
HCl (g) hydrogen chloride

In water solution: hydro (prefix) + negative stem + -ic acid
HCl (aq) hydrochloric acid

RULE 4

OTHER COMPOUNDS: compounds composed of three (or more) elements, most commonly a metal ion or hydrogen combined with a polyatomic ion (a non-metal, or occasionally a transition metal, combined with oxygen, as a general rule). Generally, it is best to memorize the polyatomic ions, along with their charges. With a few exceptions, all end in –ate or –ite. Compounds composed of metals plus these polyatomic ions are named as in (a) or (b) above, except that the name of the polyatomic ion is used in place of the nonmetallic ion. (The names and formulas of various polyatomic ions are given on your "Oxidation Numbers of Some Common Ions Sheet" sheet.

e.g.

$NaC_2H_3O_2$	sodium acetate	
$Cu(BrO_3)_2$	copper (II) bromate	or cupric bromate
$Ni(NO_3)_3$	nickel (III) nitrate	
$(NH_4)_2SO_4$	ammonium sulfate	

When the polyatomic ion is combined with hydrogen, the compound is named as an acid by changing the –ate suffix to –ic or an –ite ending to –ous and adding the word acid to the name.

e.g.	$HC_2H_3O_2$	acetic acid
	$HBrO_3$	bromic acid
	HNO_2	nitrous acid

Warm up

Compound	Cation	Anion	Formula
calcium phosphate			
potassium nitrate			
ammonium sulfate			
aluminum hydroxide			
rubidium peroxide			
lithium hydride			
calcium nitride			
ammonium nitrate			
nickel(III) sulfate			
barium nitrite			
chromium(II) phosphate			

REPORT SHEET
NOMENCLATURE WORKSHEET

METALLIC COMPOUNDS

1._____ chromium (III) chloride

2. _____gallium phosphate

3._____copper (I) sulfate

4. _____barium acetate

5._____strontium hydrogen carbonate

6. _____calcium nitride

7._____ potassium chromate

8. _____magnesium carbonate

9._____strontium dichromate

10._____ammonium phosphate

11. _____ $Al_2(SO_4)_3$

12. _____ $AuCl_3$

13. _____ $Ca(C_2H_3O_2)_2$

14. _____ K_3AsO_4

15. _____ $CuSO_3$

16. _____ Cs_2HPO_4

17. _____ $Zn(BrO_3)_2$

18. _____ $(NH_4)_2CO_3$

19. _____ $BeSO_4$

20. _____ FeO

NONMETALLIC COMPOUNDS

21. _____ PBr_3

22. _____ CF_4

23. _____ SO_3

24. _____ CO_2

25. _____ N_2O

26. _____ IF_5

27. _____ $SbCl_3$

28. _____ SiO_2

29. _____ BrF_5

30. _____SiC

31._____tetraphosphorus decoxide

32._____ diarsenic trioxide

33._____ carbon tetrachloride

34._____ carbon monoxide

35. _____ phosphorus pentabromide

36. _____bromine dioxide

37. _____carbon monosulfide

38. _____ phosphorus pentachloride

39. _____ dintrogen tetroxide

40. _____tellurium dioxide

MIXED REVIEW

41. _____ tin (IV) oxide

42._____zinc permanganate

43._____ammonium hydroxide

44. _____ silver nitrate

45. _____ iron (II) dichromate

46._____silver bicarbonate

47. _____ formic acid

48._____nitrogen triiodide

49. _____ boron trifluoride

50. _____hydrocyanic acid

51._____ hydrosulfuric acid

52._____ $Au_3(PO_4)_2$

53._____$CuHSO_4$

54._____ BI_3

55._____$FeCl_3$

MORE MIXED REVIEW

56._____ $FeAsO_4$

57._____ Arsenous acid

58._____ copper (II) oxalate

59._____ potassium iodate

60._____ ammonium dichromate

61. _____ magnesium peroxide

62._____ gold (II) cyanide

63._____ potassium hydroxide

64._____ lead (IV) oxide

65.____ _____ tungsten (IV) oxide

66. _____ palladium (II) cyanide

67._____ BF_3

68._____ NH_4I

69._____ $CoCl_3$

70. _____ NO_3

71._____ $FeAsO_3$

72. _____ mercury (II) cyanide

73._____ $HBrO_2$

74._____ $HClO_3$

75._____ lead (II) acetate